

University of Cambridge School of Agriculture Memoirs

Memoir No. 22

A summary of the papers published by the members of the Staff of the School of Agriculture and its Associated Research Organisations during the period Oct. 1st, 1949—Sept. 30th, 1950.

Review Series

No. 5. A Survey of the Horticultural Research Station, 1922—1949.



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FOREWORD

This Memoir, which is published under the general editorship of the Librarian of the School, represents an attempt to present as succinctly as possible the contributions made by members of the Staffs of the School of Agriculture and its Associated Research Organisations to the development and progress of Agricultural Science, to indicate to research workers interested the Journals in which the full papers are presented and to act as a complete record of papers published. Each summary is compiled by the author of the paper and is presented, so far as the subject matter will allow, in a non-technical form in order to be of value to the general body of farmers interested in the more recent developments of agricultural scientific research in general and of the activities of this Department in particular.

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A SURVEY OF THE HORTICULTURAL RESEARCH STATION, 1922—1949*

By

R. M. WOODMAN, C.C., M.Sc., Ph.D., F.R.I.C., F.Inst.P.
(Horticultural Research Station)

In 1920 Wright (C.W.B.) became Lecturer in the School of Horticulture for the newly instituted B.A. in Horticulture at the School of Agriculture and, in 1922, Deputy-Director of the new Horticultural Research Station, of which Biffen was made the Honorary Director. Woodman was appointed in 1922 as Research Physical Chemist to the Station, with further duties as Lecturer in Horticultural Biochemistry to the School. Later, in the same year, Maskell was appointed as Research Plant Physiologist and Lecturer in Plant Physiology. Boyes at that time was the Recorder of the Station, but had already commenced vegetable breeding.

Wright's time was chiefly occupied with teaching horticulture, administration of the Station, and advising on practical fruit-growing; but simultaneously he was interested in many other lines, e.g., the marketing and grading of fruit, of which he was a pioneer (1), the economics of fruit-growing (2), the properties of fruit soils (3), and the hydrodynamics of spraying, spray nozzles, volume of spray necessary per tree, etc. (4, 5). Wright would go to untold trouble to help those on his staff, and he was always a pleasant colleague to those working jointly with him.

Maskell and Woodman made phenological studies on the radish (the chemist well remembers showing the physiologist how to make a seed bed!), and this phenological work was continued by Vyvyan (Maskell's successor in 1923) and Woodman with radishes, beans, and peas (the teaching lesson had to be repeated!). Twice a week during summer Vyvyan and Woodman worked from 8 a.m. till about 2 a.m. the next morning, weighing and drawing leaves, etc., and the mass of accumulated data became so enormous after two or three years that even now, some 25 years later, the results are still, so to speak, 'awaiting publication'. The last Woodman heard of this scientific nightmare was about 1928, when Vyvyan, always a bit of a wag, wrote to say that, "You will be extremely annoyed to learn that there is something in the results, and we shall have to go on with them". Vyvyan also worked very industriously on the respiration of onions, and on the rate of growth of the leaves of *Phaseolus vulgaris* as studied by a photographic method (6).

Boyes and Woodman in the early twenties made a practical quantitative study of the roots of fruit trees in an orchard near King's Lynn. This, for certain reasons, had to be done in winter during a spell of cold weather, and one most vivid memory is of catching disgustingly early trains with iron hot-water bottles installed as the entirely inadequate heating system. Unfortunately the orchard had been interplanted with blackcurrant bushes, and Woodman had to separate all currant-root fibre dug up from apple-root fibre by sense of smell, a most loathsome task at about 10 degrees of frost. A full report was written, and is presumably still pigeon-holed at the Ministry. "The reward of a thing well done is to have done it".

When Wright left and the School of Horticulture was closed, leaving in being the Station only, Boyes became Deputy-Director, his main line of enquiry being vegetable breeding and selection, of which more anon. Vyvyan and Woodman still continued to lecture to agricultural students but, from 1925-39, the latter lectured on the Physics and Chemistry of Fungicides, Insecticides, and Weed Killers, instead of on Plant Biochemistry.

In the first decade or so after World War I, manufacturers of sprays, and growers were keenly interested in the physical and colloidal properties of spray fluids and dusts, in the properties of wetting and spreading, and in insecticidal emulsions and suspensions, and Woodman's main work lay in this direction from 1922-34. The properties of wetting and spreading were thoroughly investigated, force of spraying, viscosity of spray fluid, volume of fluid retained by the foliage, hard waters, etc., all being taken into account (7, 8, 9). The best protective colloid and 'sticker' for the stomach poison lead arsenate was found to be gelatine, bought cheaply as glue (10). Insecticidal emulsions were fully investigated (11, 12, 13, 14): easy methods of forming emulsions were discovered, intermittent agitation being remarkably effective generally, while temperature, concentration of emulsifier, age and viscosity of emulsifier solution, and the 'mayonnaise' addition of oil to form concentrated 'stock emulsions', were all found to be important (13-16). In view of the liability of dilute spray emulsions to cream, with subsequent scorching of the foliage by the concentrated cream on spraying, methods of preventing creaming of certain emulsions were sought and found (17).

Important problems also fully investigated connected with insecticidal emulsions concerned the use of emulsifiers yielding the desirable non-phytocidal oil-in-water type of emulsion, the conditions under which this desirable type could be made, and the formation of dual emulsions. The method of agitation used and/or the phase volume ratio employed were found to affect the type of emulsion with certain protein and lipin emulsifiers, while soaps and resinates tended to interact with calcium salts in hard natural waters to produce insoluble soaps yielding the undesirable water-in-oil type (12, 18-27). The questions of the actual solubility of oils, the preparation and conditions of formation of one-phase miscible oils which yielded emulsions merely by stirring into water, aids to dissolution for miscible oils, and other ancillary problems connected with solution, partition, and emulsion formation, were also investigated (16, 28-37).

Investigations on weed killers (38) were made by Woodman and Jones using non-toxic chlorates, etc., in general, and arsenic pentoxide for the particular case of wild onions (39); by Woodman and Wiley for prickly pear, using a 50% emulsion of 25% arsenic pentoxide solution emulsified in cresylic acid by 5% glue solution (40); and by Engledow and Woodman using soap as wetter with ammonium sulphate to suppress knot-grass (*Polygonum aviculare*) in lawns, etc. (41). Fungicide investigations included photomicrographs and

* This is the fifth of a series of articles summarizing phases of agricultural research particularly associated with the School of Agriculture since its inception. Further contributions on other work will appear in future issues.

sedimentation studies of sulphur and 'copper' suspensions such as Sulsol and Bouisol (42), and methods of determining sulphur in spray suspensions (42, 43). Tomkins of the Low Temperature Station and Woodman also published on the stalk treatment of fruit and vegetables (44), work that later resulted in a patent, signed but not sealed, for prevention of stalk rot in bananas (45). The incompatibility of fungicides and insecticides was also discussed (46, 47).

In this period it was demonstrated by Woodman and Barnell that gelatine used in spray fluids had no effect on water losses from leaves (48); the fatty substances of the growing point of the broad bean and pea were investigated by Rhodes and Woodman (49); the same authors found that quebrachitol and the lipin from *Hevea* latex were useless as spray emulsifiers (50); and Hanley and Woodman solved the problem of preparing 'treated' sugar-beet seed by the partial removal of the coating of sugar-beet clusters by concentrated sulphuric acid, and showed that seed so treated germinated more regularly than untreated seed (51).

Mellor, by now the Station Entomologist, and Woodman studied attractants for cabbage-root fly, and found that brewer's yeast was the most effective substance of those tried (52). Mellor, with Petherbridge, also studied the life history of the cabbage aphis, suggesting control measures (53). Brenchley, appointed as the Station Mycologist, laid down numerous plots for the study of club root of Brassicae, mostly at St. Neots (where the local pork pies are thoroughly recommended by Woodman, who helped him to some extent in this work); he also, together with Woodman and Hanley, showed by a statistical experiment that treatment of the soil by mercuric chloride seriously affected the seedling growth of Brussels sprouts (54).

Woodman, Taylor, Chapman and Hanley also investigated certain properties of clays, base exchange, flocculation of soil suspensions, soil reclamation, etc., in this period. The character of bentonite as a sodium clay was elucidated (55); the emulsifying powers of bentonite and allied clays, and of clays derived from these by base exchange, were studied (56); the reclamation of sodium-clay soils was investigated (57), and a sodium-clay soil in a tomato nursery (where the grower was threatened with bankruptcy as a result) was successfully and cheaply reclaimed (58); the influence of the exchangeable base present on the behaviour of clay gels under small pressures came under review (59); and the effect on the apparent specific gravity of suspending bentonites saturated with different exchangeable bases in various types of liquid was determined (60).

During 1927-31, the Station staff consisted of Boyes and Woodman only. In 1928 the Station was removed to its present site, conveniently near The Traveller's Rest. In 1931, a Mycologist, Brenchley, and an Entomologist, Mellor (later to be succeeded by D. W. Wright), were appointed; a geneticist, Preston (later to be succeeded by Dark), was appointed in 1932.

At this time, the main objects of the Station were:—to produce and distribute improved varieties of vegetables and to maintain pure stocks of the varieties produced; to study genetical problems as an aid to the breeding of, and disease prevention in, vegetables; to study the pests and diseases of vegetables, preventives and remedies, and the physico-chemical aspects of fungicides, insecticides and weed killers; to work on the manuring and cultivation of vegetables; and to give advice to growers where and when possible. In 1934 the policy of the Station, now ruled by a Committee with three growers on it, and under the chairmanship of Engledow, was definitely oriented to vegetables, and this phase has lasted till 1949, when the Station was absorbed by the new National Vegetable Research Station.

Woodman had now to turn his attention to the manuring of vegetables and to pot cultures, work humorously described by his former colleague Maskell as 'a slow, lingering form of death'. A set of 'permanent' manurial trials on a rotation of vegetables was laid down, lettuce, spring cabbage and carrots proving to be much better indicator plants than Brussels sprouts and peas. Pure silica sand was used as the aggregate for phosphate-deficiency tests on lettuce (61, 62); for the effects of variation in nitrogen supply on yield, etc., of May King lettuce (63) and of potash variation on lettuce (64, 65); and for deficiency experiments on carrots, onions, and radishes (66) and lettuce (67). The nutrition and yields of eight vegetables in sand were investigated (68), the vegetables studied being the turnip (69), spring cabbage (70), spinach (71), lettuce (72), carrot (73), onion (74), radish (75), and pea (76). It was found that vegetables could in general be successfully and more economically grown in much diluter culture solutions than was thought possible (77, 84). The work was statistical, the then new methods of field experimentation such as randomized blocks, $3 \times 3 \times 3$ layouts, etc., being successfully adapted to greenhouse pot-culture work, where light is the main variable and not soil, (84).

It was shown by Woodman and Paver that for a high yield of roots in turnips, nitrate-nitrogen should be applied early (78). These workers also investigated the growth of carrots in a fen soil deficient in phosphate (79). Woodman and his assistant, Johnson, showed that fertilizers were entirely without effect on yield of carrots on a gravel soil in good heart, but that yield of 'ware' could be more than doubled by sufficient overhead irrigation (80); they also demonstrated conclusively on a gravel soil that there was a significant positive response of carrot roots to potash, accompanied by a significant negative response of tops, so that the top/root ratio was abnormally large with extreme deficiency of potash (81), as had been shown earlier by Woodman with sand cultures of Primo carrots (73) and by Woodman's field plots (73, 81). Effect of time of sowing and of water supply on the growth, yield and hearting of lettuce was also studied (82, 83). Now the effect of fertilizers on the growth, yield, hearting and bolting of lettuce is receiving attention.

Woodman and Johnson also compared the growth of vegetables with nutrient solutions in sand and soil cultures; they reviewed the culture work already done (84), and then demonstrated that soil was a better aggregate than sand for yield of turnips and cabbage under comparable conditions (85) and even when conditions were greatly biased in favour of the sand (86), the advantage lying in the capacity of a soil for base exchange, etc. A comparison of the effects of phosphate on turnips grown in fen and gravel soils and in sand was also made, and it was shown that no adverse effects on yield, etc., followed over-dosage by water-soluble phosphate in soils as they did in sand (68, 87). In this period Woodman and Barnell also studied water losses from stored onions, and demonstrated that a high relative rate of loss was characteristic of non-keepers, especially just after harvest (88).

Boyes, Director of the Station for the last half of the period under review, is possessed of the 'pomological eye' and excels in the art of plant breeding. He is a born gardener, and has a large knowledge of garden crops and flowers and a fund of sensible advice that must be a comfort to the young scientist making his first hesitant attempts at growing plants under controlled conditions. He is obviously no believer in publication, but his products have obtained great respect for the Station: go into any well-conducted kitchen garden or vegetable holding and look around you, and you will invariably see some products of his art. His practical achievements rank with those of Saunders, Hunter and Biffen, the famous cereal breeders, although, easily chafed by lack of facilities, he probably quite failed to realize the amount of work he and his few colleagues actually turned out in 25-30 years.

He realized that the material for building up stocks of vegetables that were uniform as regards size, colour, earliness, disease resistance, etc., were already present in commerce, and he resolved to 'improve' existing stocks of vegetables, perceiving that in this lay a lifetime's work apart altogether from the genetic study of vegetables (89). To obtain 'practical results', his chosen course was the selection of vegetables combined with a commonsense application of the Mendelian method: first he ascertained growers' complaints about existing vegetable varieties, and then made a preliminary survey of all the available material; he then made a trial of any stocks likely to contain material suitable for breeding purposes, and selected plants possessing all or some of the desired characteristics. His work ranged over Brussels sprouts, broccoli, cabbage, cauliflower, cannning beans, celery, gherkins, lettuce, pickling and ordinary onions, parsnips, market and cannning peas, and strawberries, special attention being given to sprouts, cauliflowers, broccoli, peas and strawberries.

The Station is famous among growers and gardeners for his Cambridge sprouts. Boyes's method for breeding these was to make a preliminary investigation of commercial cultures by testing out commercial varieties, and to select plants with one or more desirable characters; he then built up, by crossing and selection, strains that were uniform for the desired characters.

Boyes's work with broccoli, cauliflower and cabbage followed on similar lines. Cannning peas and beans have also been bred, while his former assistant, Dark, has put out a multipodded pea. In wartime, in 1941, Boyes wrote a very necessary guide to the production of vegetable seeds in gardens (90), and dealt with Brussels sprouts, cauliflower, broccoli, cabbage, savoy, kale, peas, radish, turnip, swede, French bean, runner bean, onion, leek, beet, carrot, parsnip, celery, lettuce, parsley, vegetable marrow, spinach, and gherkins. He was also interested in the haricot bean (91).

Strawberries are not vegetables; but they were Boyes's hobby-horse, and openly flourished at the Station, although the official eye became instantly quite Nelsonic when turned towards them. Using strawberries from many parts of the world, he produced new strawberry seedlings of remarkable vigour and constitution yielding berries of good flavour. The aims were to obtain firm, wedge-shaped or conical fruit of good flavour, texture, and bright colour, that would hang on the plant (or keep in this condition after picking) when ripe for several days. Over a period of 18 years Boyes produced many derivatives, all self-fertile, of Early Cambridge, Royal Sovereign, Huxley Giant, and *Fragaria chiloensis*. Among these are cultures suitable for most types of soil, for cultivation in cold frames, cloches or gardens, and for forcing in pots; and fruit from one or other of these cultures can be found useful for all purposes such as the fresh fruit market, jamming, cannning and quick freezing. The work of maintenance, etc., of these strawberry seedlings was handed over to a commercial nursery in 1944.

One serious drawback to the Station site, fully realized by Boyes and Woodman who had to grow vegetables there, was the lack of overhead irrigation. Boyes always rightly stated that water was the limiting factor in vegetable production, and the provision of overhead irrigation would undoubtedly have greatly added to the value of the field work done at the Station.

Dark has described and illustrated the flowers from the curd of the broccoli (92). He, together with Booth of the School of Biochemistry, also made an extensive survey of the carotenoid content of different varieties of carrot, and improved the content of the most nutritious in this respect by appropriate selections (93).

Wright (D. W.) has been the Station Entomologist for more than a decade and has systematized investigations on economic entomology here. His earliest work dealt with the biology, ecology, and methods of control of the cabbage-root fly (94-96) and of the onion fly (97, 98). Treatments based on the use of calomel were developed to combat these, this chemical being applied to the plant either as a four per cent. dust prior to the attack, or, with the onion, to the seed as the pure substance prior to sowing. Wright then further developed his work on mercurials, and demonstrated that mercury vapour was toxic to a wide range of insect eggs. Mercury in various forms was shown to be effective as a preventative against the breeding of grain weevil and other insects infesting stored grains, and this effectiveness was increased by subdivision of the mercury, which metal was found to have no deleterious effects in any way on the grain (99).

The general scheme behind Wright's investigations is to make detailed biological and ecology studies to give a background on which to base the proposed measures of control. Attention is also paid to parasites of the pest and to cultural control, as these may substantially lower the general level of the incidence of the pest pest. Thus, in designing methods of chemical control, the aim is to effect maximum control of the pest concerned with minimum disturbance to the parasites that attack the pest and, of course, to the plant.

Detailed studies have been made of the biology, incidence, ecology, and methods of control of the carrot fly in joint investigations with Petherbridge, Davies, Ashby, and Geering (100-107). This fly was shown to have a marked tendency to shelter on the outskirts of a crop, so that it was merely necessary to apply insecticides to the headlands and adjoining vegetation surrounding the main bulk of the crop to give control; some of the insecticides proposed are still in use. Methods of cultural control, and population changes following on different types of cropping, were also studied, together with a comparison of the rates of deterioration due

to the fly occurring in clamped and unlifted carrots. Forecasts of possible damage to the crop caused by the carrot fly were also made.

Investigations on the biology, incidence, ecology, and methods of control of the pea moth have also been undertaken (108, 109), the incidence of parasitism and the relative importance of the species concerned receiving attention. The variety of pea grown was found to influence the susceptibility of attack by the moth, quickness of maturation and amount of foliage of the pea being important factors in this regard. A D.D.T. emulsion, applied shortly after flowering, was the most effective control measure used.

Wright has collaborated with Petherbridge on work on the cabbage aphid (110), and has also discussed the control of lettuce aphid (111). At the present time he is concentrating on insecticidal dusts for vegetables, paying particular attention to the important points of particle size of the insecticide and to the method of its incorporation with the carrier employed.

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[Since 1st October, 1949, the work and certain members of the staff of the Horticultural Research Station at Cambridge have been transferred to the new and more spacious Vegetable Research Station at Wellesbourne, Warwickshire under the Directorship of Dr. J. Philp. This station now comes under the scientific oversight of the Agricultural Research Council.] (ED.)

*Limited reprints available for free distribution. Please quote marginal number instead of full title. Enquiries for papers not starred should be sent to the author.

AGRICULTURAL ECONOMICS

†A Survey of the Cost of Producing Barley in Two Districts in the Eastern Counties, 1949.
Fm Econ. Br. Mimeog. Rep. No. 40. 1950.

†A Survey of the Cost of Producing Linseed in Two Districts in the Eastern Counties, 1949.
Fm Econ. Br. Mimeog. Rep. No. 41. 1950.

STURROCK, F. G.

Farm Accounting and Management. 2nd ed.
Pp. xii+211. Pitman, London, 1950. 16s.

982* STURROCK, F. G.

The Productivity of Labour in Agriculture.
J. Proc. Agric. Econ. Soc. 1950, 9, 34-53.

Labour efficiency is a matter of increasing importance to the farmer. This can be shown from the results of surveys carried out in the Eastern Counties of England. Between 1938 and 1948, the cost of hired labour increased from 27 per cent to 37 per cent of the total farm expenditure and had become by far the largest single item. This area is one well suited to mechanisation and it is not surprising to find that the upkeep of machinery has increased fivefold or from 9 per cent to 21 per cent of the total costs. For working purposes, the "man and his machine" are one, and it will be seen that these two items now account for 58 per cent of the total cost of running the farm.

It follows, therefore, that efficiency in the use of labour—particularly in relation to mechanisation—is of vital importance in the farm economy and one well worth further research. Various means of measuring productivity are examined and of these "work units per man" is suggested as the most appropriate. This method (first devised in the U.S.A.) measures productivity in terms of the acres of crops or numbers of livestock "managed" by each worker—each crop or type of livestock being weighted according to its average labour requirements.

Using this method on data derived from the Eastern Counties, it was found that the amount of work accomplished per worker (taking 1936-38 as 100) was as follows:—

1941-44	100
1946-48	93

It is disturbing to find that in spite of the fact that these farmers are better equipped with implements and machinery than ever before, work accomplished per worker shows no sign of increasing. Moreover, productivity per man on large farms which have the fullest scope for utilizing mechanisation, is little greater than on medium sized farms.

The problem of increasing productivity is by no means confined to agriculture. Productivity per worker in industry is in many cases appreciably less than, for example, in the U.S.A. and has not increased since 1939 in spite of increased mechanisation. In certain cases, however, substantial improvements have been effected by the use of "work analysis", and there appears to be scope for this method in agriculture.

The remainder of the paper summarises work on these lines accomplished in Cambridge, on the use of combines, methods of threshing and the use of labour in milk production.

VENN, J. A. (*Chairman*)

Report of a Committee of Enquiry into the Sugar Industry of British Guiana.
Pp. x+184 with 2 maps. Col. No. 249. H.M. Stat. Office, London, 1949. 4s. 4d., post free.

OTHER PAPERS

BANCROFT-WILSON, J. A. **System for Success with Pigs.** *Fmr and Stk-Breed.* 1949, 63 (3130), 2565.

STURROCK, F. G. **Labour Organisation in Milk Production.** 4. *Home Fmr.* 1949, 16 (12), 21-3.

993* WALLACE, D. B. **Costs and Profits in Pig Production.** *Fmr and Stk-Breed.* 1950, 64 (3150), 561.

AGRICULTURAL ZOOLOGY (including Entomology)

987* JONES, F. G. W.

A New Species of Root Eelworm attacking Carrots.
Nature, Lond. 1950, 165, 81.

This new species of root eelworm (*Heterodera carotae* Jones) was found attacking carrots in the Chatteris area of the Isle of Ely. Its presence in this important carrot-growing area is a menace to the intensive cultivation of carrots. Further spread is to be anticipated, and, should this occur, it would add to the difficulties already experienced in the area which arise from the prevalence of the Carrot Fly (*Psila rosae*) and the Beet and Potato Root Eelworms. Host range trials indicate that the Carrot Root Eelworm is highly specific and attacks only carrots and wild carrots among the common field and vegetable crops and weeds.

† Continuation of the War Series Reports. Obtainable from the Farm Economics Branch.

1002* WHEATLEY, G. A. & MOCZARSKI, S. Z.

An Insect Barrier Utilising High-Frequency Current.

Nature, Lond. 1950, **165**, 766-7.

An account is given of a new type of electrical insect barrier, designed to confine apterous insects to the proximity of their host plant.

The disadvantages of a direct current can be overcome by using an alternating current of high frequency. A potential effective against the escape of pea aphids is 35 volts at 1000 c./sec.

OTHER PAPERS

DUNNING, R. A. & JONES, F. G. W. **Mangold Fly : its Life-History and Control.** *Brit. Sugar Beet Rev.* 1950, **18**, 153-7.

AGRICULTURE

BUTTRESS, F. A.

Agricultural Periodicals of the British Isles, 1681-1900, and their Location.

Pp. 16. School of Agriculture, Cambridge, 1950. Price 2s.

An attempt has been made to trace the progress of agricultural periodical literature up to the end of the 19th Century, the issue of John Houghton's *Collection for the Improvement of Husbandry and Trade* first published in 1681 being recognised as the first attempt to produce a scientific agricultural paper.

In general, periodicals relating to Botany, Economics, Forestry, Gardening, Horticulture and Veterinary Science have been omitted. Herd, Flock and Stud Books have also been omitted.

OTHER PAPERS

MANSFIELD, W.S. **Sheep on the Mixed Farm.** *The Times Survey of British Agriculture.* Dec. 1949. p. 3.

ANIMAL BEHAVIOUR

1015* WALTON, A.

Patterns of Male Sex Behaviour.

Proc. Soc. Study Fertility. 1950, **1**, 40-44.

The male pattern is not sex specific and not dependent upon the possession of male organs. If motivated by androgens, the threshold concentration of these must be low, as in the immature animal or in the female, and in the latter case, must be derived from another source than the testis.

The pattern is innate and not learned.

The pattern is instinctive, due to an endogenous "drive" which in the absence of normal outlet may find a substitute outlet. Sex drive increases with postponement of outlet and decreases after an outlet has been found.

The objects which provide a sexual outlet differ in their capacity to elicit response, and males differ in their responsiveness to sexual objects. Response is elicited by the sum of the excitatory value of the sexual object and the sex drive of the male.

Response is not "all or nothing" but graduated by varying completeness of expression. The complete pattern involves a succession of motor activities. Erection and ejaculation usually accompany the motor activities but co-ordination with the pattern is not absolute. Erection and ejaculation are reflexly motivated through the autonomic nervous system.

Performance of the sexual pattern may be facilitated or inhibited by the development of conditioned reflexes. Response is elicited by the sum of the sex drive (increased by abstinence or decreased by use) and the algebraic addition of conditioned facilitation or inhibition.

ANIMAL BREEDING AND GENETICS

1009* COCK, A. G.

A Case of Incomplete Twinning in the Rabbit.

J. Genet. 1950, **50**, 59-66.

A monstrous Dutch rabbit with a single head and a double thorax and abdomen is described, and its probable mode of origin discussed. It is concluded that while it is primarily a result of incomplete twinning, a considerable degree of secondary fusion has taken place.

The two members of the monster have different pigmentation patterns ; it is suggested that this is due to the same (unknown) causes as the asymmetrical markings of 'mismarked' Dutch rabbits.

An attempt has been made to obtain statistical evidence that normal monozygotic twins occur in rabbits. The results were inconclusive ; while not giving any evidence in favour of their occurrence, they provide no reason for supposing that they are particularly rare.

990* HAMMOND, J.

Pig Breeding.

Pig Breed. Gaz. 1950, **61**, 25-9.

A short account is given of the characters which are required to be bred for in commercial pigs, under the following headings: Fertility; good mothering qualities in the sow; good weaning weights and good growth rate.

Ways in which we can best achieve these are by pig recording and by litter testing.

1006* HAMMOND, J.

Polled Cattle.

Endeavour. 1950, **2** (34), 85-90.

An account of the history of polled cattle is given. Methods of artificial de-horning are referred to and the production of polled breeds of horned cattle by the development of mutation or cross-breeding is outlined.

OTHER PAPERS

HAMMOND, J. **Pig Breeding.** *Rep. Nat. Pig Conf.*, Harper Adams Agric. Coll., Newport, Salop, March, 1949. Pp. 11-16.

HAMMOND, J. **Process of Reproduction.** *Brit. Cattle Breed. Cl. Dig.* 1950, **5**, 326-38.

HAMMOND, J. & RICHENS, R. H. **Genetic Factors Affecting the Nutritional Value of Animal Products and Crops.** *Chem. and Industr.* 1949 (49), 851-2.

PEASE, M. S. **Auto-sexing Breeds of Poultry (Demonstration).** *Heredity.* 1949, **3**, 377.

PEASE, M. S. **Hybrid Vigour.** *Brit. Cattle Breed. Cl. Dig.* 1950, **5**, 307-25.

PEASE, M. S. **Inbreeding from the Utility Point of View.** *Mod. Poult. Keep.* 26 Oct., 1949.

1022* PEASE, M. S. **Some Problems of Inbreeding.** *News Serv. Accred. Poult. Breed. Fed. Ltd.* Sept. 1949.

PEASE, M. S. **The Wybar.** *Autosex. Ann.* 1950, 6-7, 12.

ANIMAL NUTRITION

978* HUTCHINSON, J. C. D. & BAKER, C. J. L.

Nutrition of Domestic Rabbits. 3. Variations in Carcass Composition of Rabbits Reared for Meat.

Brit. J. Nutrit. 1949, **3**, 12-24.

A relationship was found to exist between the percentage edible fat of the dressed carcasses of rabbits and the weight of certain depot fatty tissue which can be easily dissected out. This 'dissected fatty tissue' comprised fatty tissue round the kidneys and that over the shoulders and the pubic region.

It is suggested that the relationship may be used for the prediction of the edible-fat content of dressed carcasses.

Between the ages of 7 and 15 weeks the relationship was independent of age, sex and live weight; it was also unaffected by wide variations in nutritional treatment.

The relationship held for the offspring of parents of mixed Flemish-Giant and Belgian-Hare breeds, and for the progeny of does of a Dutch type crossed with a Chinchilla buck. No experiments were carried out to ascertain whether the relationship holds for other breeds.

A greater proportion of the edible fat of the dressed carcass was present in the 'dissected fatty tissue' of fat rabbits than of lean rabbits.

In general the percentage of edible protein of the fat-free dressed carcass increased as the dressed-carcass weight increased.

OTHER PAPERS

1003* HALNAN, E. T. **Dried Grass as a Feeding Stuff.** Pp. 22. *Nat. Ass. Corn. and Agric. Merch.* 1949.

976* HALNAN, E. T. **Nutritional Levels for Livestock.** *Nature,* Lond. 1949, **164**, 641-2.

WOODMAN, H. E. **Early History of Grass-drying.** *Green Crop Dryers' Res. Ass. Yearb.* 1949, 34-5.

ANIMAL PHYSIOLOGY

1013* DOWLING, D. F.

Problems of the Transplantation of Fertilized Ova.

J. Agric. Sci. 1949, **39**, 374-96.

The object of this investigation has been to advance knowledge of the methods necessary for the practical application of the transplantation of fertilized ova in cattle.

The induction of ovulation at any specific time can be produced by squeezing out the corpus luteum per rectum. Oestrus occurs from 2 to 4 days afterwards; this is accompanied by ovulation and the ova so produced are readily fertilized. The onset of oestrus after the expression of the corpus luteum is hastened by previous treatment with P.M.S.

The induction of multiple ovulations is necessary to produce an augmented supply of fertilized ova, but it is of primary importance that the ova so produced are fertilized, viable and capable of full development. Four methods of doing this have been tested.

In the first method 3000 i.u. of P.M.S. were injected subcutaneously in the luteal phase of the cycle (4th to 10th day from oestrus) and the corpus luteum was squeezed out of the ovary 4 days afterwards, the cow

being inseminated when she came on heat. Multiple ovulations (average 6.6, and up to 18 ovulations) were obtained, but, although a few of the cases gave a satisfactory response, in some cases there was no response, and in many cases there was overstimulation of follicles in the ovaries with but few ovulations. In these latter cases passage of the ova through the Fallopian tube was accelerated and there was poor fertilization; in all only 38% of the ova were recovered, and of these recovered ova only 38% were fertilized. No intravenous ovulatory dose of L.H. is necessary in the cow and multiple ovulations occur within a short period of one another.

In the second method 3000 i.u. of P.M.S. were injected subcutaneously in the follicular phase of the cycle (16th to 18th day from oestrus) and the cow was inseminated when she came on heat. Many multiple ovulations (average fifteen and up to fifty-one ovulations) were obtained. While this is a better method than the first there were many cases of 'overstimulation' of the ovaries, giving rise to accelerated passage of the ova through the Fallopian tubes, increasing the number of unfertilized ova, and many of those ova which were fertilized had a non-viable appearance (called 'P.M. Sified'). These findings may have a bearing on many of the naturally occurring cases of sterility in the cow.

In the third method 100 mg. of horse anterior pituitary extract were injected subcutaneously daily for 3 consecutive days in the follicular phase of the cycle (14th to 20th day from oestrus), and insemination was made when the cows came on heat, usually from 2 to 5 days afterwards. The maximum number of ovulations obtained was twenty-five and the average 6.5. The reactions on the ovary were physiological in that the ova were not noticeably accelerated in their passage down the tube, and over 90% of the ova recovered were fertilized. In the case of the twenty-five ovulations all the ova were fertilized and recovered in the 8-16-cell stage. This was considered to be the most satisfactory method.

In the fourth method a subcutaneous injection of 3000 i.u. of P.M.S. was given at the time of mid-cycle expression of the corpus luteum. Only one cow was treated in this way. The ovarian response was physiological; there were eighteen ovulations and of the ten ova recovered all were fertilized and in the 8-cell stage.

Since in the cow the ova would have to be transplanted into the uterus, preliminary experiments were made with rabbits to find out the conditions under which this could be done with some degree of certainty. Fertilized superovulated ova from albino does mated with an albino buck were washed out of the Fallopian tubes 62-64 hr. after ovulation (in the morula stage) in rabbit blood serum and transplanted into black does which had been mated with a vasectomized buck 24 hr. before the donor albino doe was mated. Thirty-two fertilized ova were transplanted into five does and 78% of these produced normal young, twenty-one of which grew up into normal adults. The certainty of these results is promising for work on other species when the necessary technique has been worked out.

Actual transplantation of fertilized ova in the cow was attempted in eight cases only and in all cases was unsuccessful, due it is considered mainly to the unpromising material used (cows sent for slaughter) and to the fact that many of the superovulated ova used had a non-viable appearance ('P.M. Sified'). A method of collecting ova from the living cow by washing out the ova at the upper end of the uterine horn 4 days after the end of oestrus was successful in two out of six attempts. The ova were collected from the Fallopian tubes of the donor cows by washing out in either homologous or heterologous blood serum, and were transplanted through the cervix into the anterior end of the uterine horn of the host cows with a 'heifer' inseminating tube in a small quantity of cow blood serum.

992* HALNAN, E. T.

The Architecture of the Avian Gut and Tolerance of Crude Fibre.

Brit. J. Nutrit. 1949, 3, 245-53.

In this account a concise description is given of the gross structure and histology of the digestive tract of the fowl, the co-ordination of the movements of the tract and the passage of food through it as determined by X-ray methods and examination of the food contents in various regions of the gut; and a critical summary of the experimental evidence dealing with the tolerance of the fowl for crude fibre, including a discussion on the extent of the ability of the fowl to digest crude fibre and the effect of the level of crude fibre in poultry mashes upon the availability of the other food nutrients. The article contains 4 X-ray photographs illustrating characteristic features of the passage of food through the gut of a fowl.

977* HAMMOND, J.

Physiology of Reproduction in Relation to Nutrition.

Brit. J. Nutrit. 1949, 3, 79-83.

A short review of recent work dealing with the effects of nutrition on the age of puberty, the number of eggs shed, sperm production and foetal atrophy.

1004* HAMMOND, J.

The Possibility of Artificial Pregnancy in Cattle.

Agriculture, J. Minist. Agric. 1950, 57, 67-70.

A popular account of the problems connected with the transplantation of fertilized ova, and the possible ways in which it can be made use of in the cattle industry of this country if the technique can be perfected.

1014* HAMMOND, J.

Problems Concerning the Transplantation of Fertilized Ova or "Artificial Pregnancy".

An. Fac. Med. Montevideo. 1950, 35, 810-19.

The problems concerning the successful application of technique are outlined and a summary is given of recent work on this subject. Short reference is made to the problems which could be solved when the technique of transplantation has been perfected.

1017* HAMMOND, J. jun.

Induced Twin Ovulations and Multiple Pregnancy in Cattle.

J. Agric. Sci. 1949, **39**, 222-5.

Cows were treated with various doses of pregnant mare serum gonadotrophin given either towards the end of the normal cycle, or prior to expression of the corpus luteum. The animals were kept under normal farm conditions; the object of treatment was to obtain twin ovulations and calvings.

Some success was achieved but of the treatments tried none could be considered commercially worth while; many variants of treatment are possible and much more requires to be done. For practical application it is important that a treatment should not, or only rarely, result in more than three ovulations. The few cows reported in this paper which were pregnant and which had more than three corporea lutea aborted at about 5 months.

980* LAING, J. A.

Infertility in Cattle Associated with Death of Ova at Early Stages after Fertilisation.

J. Comp. Path. 1949, **59**, 97-108.

Forty-eight heifers, in two groups of 24, were mated, in successive years, under controlled conditions to determine whether infertility resulted from death of fertilised ova.

The condition was found to occur in both groups.

The aetiology of the infertility is discussed and it is suggested that it may be associated with anomalies of the later stages of follicle maturation.

The relationship of the condition to general bovine infertility is considered.

1008* MANN, T. & PARSONS, U.

Studies on the Metabolism of Semen. 6. Role of Hormones. Effect of Castration, Hypophysectomy and Diabetes. Relation between Blood Glucose and Seminal Fructose.

Biochem. J. 1950, **46**, 440-50.

The withdrawal of male sex hormone through castration causes the disappearance of fructose and citric acid from seminal plasma, but the formation of both these substances is re-established on administration of testosterone. There is a quantitative relation between the amount of testosterone administered and the production of fructose and citric acid, so that the assay of these substances in the accessory organs can be used as a sensitive and simple 'hormone indicator test'. Hypophysectomy also causes an inhibition of fructose and citric acid secretion, but this can be restored by administration of gonadotrophin or testosterone. A relation is demonstrated between blood glucose level and the level of seminal fructose.

MAQSOOD, M.

Effects of Hypo- or Hyperthyroidism on the Internal Body Temperatures of the Rabbit and Sheep.

Vet. Med. 1950, **45**, 340.

Thyroidal stimulation within the physiological limits did not show any marked effect on the rectal temperatures of the young male rabbit and the ram. Administration of larger doses of thyroidal materials resulted in a significant increase in the rectal temperature of the male rabbit. The increase above the normal body temperature of the thyroxine treated rabbit during the summer season was relatively higher than that observed during the winter season.

Thiouracil treatment or thyroidectomy resulted in a significant decrease in the rectal temperatures of the young male rabbit and the ram.

MAQSOOD, M.

The Effect of Varying Levels of Thyroidal Stimulation on Adrenals under Different Environmental Temperatures.

Vet. Med. 1950, **45**, 339-40.

In a series of experiments it was observed that thyroidal stimulation within the physiological limits resulted in a significant increase in the weight of the adrenals in the young male rabbit. Administration of larger doses of thyroidal materials, for longer periods, caused a decrease in the weight of the adrenals, indicating that the time relationship is an important factor in the response of the adrenals to prolonged thyroidal stimulation, as after having caused hypertrophy of the adrenal cortex, it later on led to its exhaustion. Thyroidectomy or thiouracil-treatment resulted in a significant decrease in the weight of the adrenals in the young male rabbit.

High environmental temperature, i.e. 30°C. caused a decrease in the weight of the adrenals in the male mouse, probably due to a decrease in the thyroid hormone secretion rate, as the administration of small doses of thyroxine checked to some extent the decrease in the weight of the adrenals.

MAQSOOD, M.

Histological Studies of the Liver in Hyperthyroidism.

Vet. Rec. 1949, **61**, 505.

Macro- and microscopic examination of the livers of thyroxine-treated mice did not reveal any pathological changes. However, a number of neutrophils were seen in the hepatic sinusoids.

MAQSOOD, M.

In vitro Effects of Thyroxine on Oxygen Consumption of Mammalian Spermatozoa.
Proc. 18th Int. Physiol. Congr. Copenhagen. 1950, pp. 353-54.

It was observed that the addition of d, l-thyroxine in concentrations from 0.1 to 12 mg. and of thiouracil from 4 to 64 mg. to 4 c.c. of diluted bull semen samples, did not show any immediate effects on the oxygen consumption of the sperm, *in vitro*. However, on storage with 0.5 to 2 mg. of d, l-thyroxine for 24 to 44 hours at +5°C., bull semen samples having original sperm concentrations above 700 million/c.c. showed an increase in the O₂ consumption per 100 million sperm when compared with the controls. The effects of thyroxine were more marked after 44 hours storage than after 24 hours. Thyroxine exerted its effects in the whole semen while it had no effects on the very little O₂ uptake of seminal plasma or on the oxygen consumption of washed sperm suspensions. Addition of thyroxine did not show any effect on the O₂ uptake of boar semen samples.

MAQSOOD, M.

Role of Thyroid Status on Growth, Reproduction and Egg Production in Poultry.
Ind. Vet. J. 1950, **26**, 385-91.

The role of the thyroid in the field of poultry husbandry has been reviewed in the light of the previous work.

MAQSOOD, M. & REINEKE, E. P.

The Influence of Variations in Environmental Temperature and Thyroid Status on Sexual Development in the Male Mouse.
V^e Congr. Int. Zoot., Paris, 1949. Gen. Rep. pp. 73-8.

The results obtained in the present experiments indicate that mild hyperthyroidism stimulates while hypothyroidism depresses sexual development in the growing male mouse at environmental temperatures of 24° and 30°C. High environmental temperature of 30°C, alone caused a decrease in the weights of testes and seminal vesicles. Histological studies of the testes and seminal vesicles showed that mild hyperthyroidism stimulated epithelial proliferation of the mucosa of the seminal vesicles, with numerous granules, when compared with the control or hypothyroid male mouse. Hypothyroidism produced by the administration of thiouracil or by keeping the mice at 30°C. caused some atrophic and degenerative changes, with limited spermatogenesis. In thiouracil-treated mice some degree of desquamation and inactivity of the epithelial cells lining the mucosa of seminal vesicles was also observed.

These results suggest some interesting possibilities for thyroid therapy in livestock, particularly under conditions where the thyroid functions may be subnormal. However, the exact role of the thyroid in the field of reproductive physiology will need to be established for each species of animal before such therapy can be used under field conditions.

1021* PARSONS, U.

Fructose in Rabbit Semen. A Study of Normal Fluctuations, and Changes Evoked by Testosterone and Stilboestrol.

J. Endocrinology. 1950, **6**, 4-14.

The level of fructose in the semen of a normal buck rabbit may fluctuate between 650 and 1,500 µgr. fructose per ejaculate. The average seminal fructose level of different individuals may vary between 280 and 962 µgr. per ejaculate. Fructose disappears from rabbit semen after castration, but the normal fructose level can be maintained, restored or enhanced by administration of testosterone. Stilboestrol inhibits fructose formation in normal rabbits and counteracts the stimulating effect of testosterone on seminal fructose production in castrated rabbits.

1025* TOSIC, J. & WALTON, A.

Metabolism of Spermatozoa. The Formation and Elimination of Hydrogen Peroxide by Spermatozoa and Effects on Motility and Survival.

Biochem. J. 1950, **47**, 199-212.

During aerobic metabolism of washed suspensions of bull spermatozoa in egg-yolk medium, a potent inhibitor of respiration and motility is formed. The inhibition is reversed by catalase and peroxidase, but not by heat-inactivated catalase, cytochrome c, haematin or ferrous ion.

The inhibitor, which is not initially present in the egg yolk, is formed in the presence of molecular oxygen from a substrate present in the egg yolk and in its dialysable portion, but not in the non-dialysable fraction.

The dialysable substances of the egg yolk have been fractionated by treatment with organic solvents and the fractions tested for their effects upon oxygen uptake and motility, and examined chemically.

The inhibitor was identified chemically as hydrogen peroxide, and was shown to be formed simultaneously with ammonia, as the result of an oxidative deamination by the spermatozoa of a component of one fraction. The fraction was replaceable with the same effect by L-phenylalanine, L-tyrosine and L-tryptophane, but not by any of ten other amino-acids tested.

Hydrogen peroxide has also been detected as a metabolic product of living spermatozoa of the boar and ram.

The toxicity of the low concentrations of hydrogen peroxide formed in metabolism has been confirmed by adding comparable amounts of hydrogen peroxide to suspensions of spermatozoa. Hydrogen peroxide has a toxicity comparable to phenyl mercuric acetate which is the most toxic spermicide known.

The formation of toxic concentrations of hydrogen peroxide is related to the small hydrogen peroxide decomposing activity of semen, and the latter has been compared in different species for whole semen, seminal plasma and washed cells. Washed cells and plasma are both active. Heating up to 82°C. for 15 min. almost entirely destroys the activity, indicating that the latter is enzymic (catalase).

These findings have been discussed in relation to preservation of spermatozoa *in vitro* and their survival *in vivo*.

981* WALLACE, C.

The Effects of Castration and Stilboestrol Treatment on the Semen Production of the Boar.
J. Endocrinology. 1949, **6**, 205-17.

Regular weekly collections of semen were made over periods of 5-8 months from normal and stilboestrol-treated boars. One animal was vasectomized and later castrated during the course of collections.

There were great individual fluctuations both in the volume of accessory secretion and in sperm numbers among normal boars. Stilboestrol treatment started during the course of collections had no apparent effect, but semen from animals carrying implants since youth was low in volume. It contained a rather high proportion of slimy jelly, much cellular debris and a high density of sperm. Total sperm output was probably not reduced. When the stilboestrol tablets were removed, a return to more normal quantity and quality of the semen was observed.

Castration was followed by a marked fall in the volume of the semen but its proportions and consistency remained unchanged.

Sexual behaviour was apparently unaffected by oestrogen though greatly altered by castration.

984* WALTON, A.

Spermatogenesis and Nutrition.
Brit. J. Nutrit. 1949, **3**, 83-6.

This is a review article of the subject, in which calculations are made of the total output of the various constituent substances of semen. From these calculations it is concluded that spermatogenesis and male reproductive functioning do not exert any appreciable drain on the metabolic turnover of the animal.

OTHER PAPERS

GILMOUR, D. G. **What Can Blood Tell?** *Dairy Short. J.* 1949, **18**, 599.

1023* POMEROY, R. W. **Animal Research Station.** *Farming.* 1950, **4**, 182-6.

1016* PARSONS, U. **The Effect of Testicular Hormone on the Formation of Seminal Fructose in Rabbits.** *Proc. Soc. Study Fertility.* 1950, **1**, 24-5.

ANIMAL PRODUCTION

HALNAN, E. T.

Poultry Production in the Eastern Counties.
Rep. Proc. Brit. Soc. Anim. Prod. 1949, **12**, 54-62.

An historical account of the development of poultry production in the Eastern Counties of England 1924 to 1949, in which the varying influences of cereal grain prices, research and education and scarcity of poultry foods during wartime are considered as probable factors in determining the kind and numbers of poultry kept. It is suggested that both commercial egg production and poultry meat production will in future tend to be concentrated on the general farm in the corn growing areas and that this trend will favour the continued existence of the specialised breeders and the big hatcheries upon whom the farmer will tend to rely for the replenishment of his poultry stocks. The development of turkey rearing and fattening under intensive systems of management in areas outside the Eastern Counties is considered likely to result in the turkey breeders in the Eastern Counties concentrating on the supply of hatching eggs and pouls for this purpose as being more remunerative than the present practice of rearing and fattening the turkeys on the home farm.

1024* HAMMOND, J.

Commonwealth Contributions and British Requirement of Meat.
Brit. J. Nutrit. 1950, **4**, 77-9.

Changes in consumption and supplies due to the present position are considered in relation to the possible future contributions of beef, mutton and lamb, pork and poultry meat from Commonwealth sources.

994* HAMMOND, J.

Requirements of and Methods of Obtaining an Ideal Dairy Cow.
V^e Congr. Int. Zoot., Paris, 1949. Gen. Rep. pp. 95-103.

High lifetime yields of milk and/or butter fat give the best economic returns and for this reason it is advisable to select bulls from old cows with high lifetime records of production and sired by old progeny tested bulls. If this is done a conformation suited to milk production and long life will follow. It is better to record yields of milk and butter fat by weighing them than to make a guess at them by looking at the conformation of the cow. Conformation is to a large extent dependent on the plane of nutrition on which the animal is reared. The advent of the milking machine however calls for a shapely udder and teats and a polled animal. Conformation suitable for beef purposes is required in dairy cows in those countries which have to obtain their steers for beef from this source, and this can be augmented by artificial insemination from beef bulls.

1018* HAMMOND, J.

Some Problems Confronting the Dairy Farmer.
Spillers Livestock Mag. 1950, No. 50.

The following questions are dealt with : Should one breed pure or crossbred for milk production ? What is the best way of getting a pure-bred high-yielding herd without great expenditure of capital ? To which breed should I "grade up" my dairy herd ? Is a dual purpose (Milk-Beef) breed possible ? Should I "milk record" and cull the poor yielders out of the herd and so improve my yields ? What do you mean by a good constitution in a cow and should I select for cows of this sort ? At what age should I calve down my heifers ? If I feed my heifers too well and get them fat will they milk properly ? Should I "steam up" my cows and heifers before calving ? Should I milk my cows two or three times a day ?

1010* POMEROY, R. W.

Production and Supply of Meat.
Brit. J. Nutrit. 1949, 3, 380-9.

The question of production and supply of meat consumed annually in the United Kingdom is considered in relation to consumption in the past and in the future. The sources of supply at home and overseas are dealt with. Steps which could be taken to bridge the gap between our present and our desired consumption of meat are outlined.

MANSFIELD, W. S.

Beef from Dairy and Dual Purpose Calves.
Rep. Proc. Brit. Soc. Anim. Prod. 1949, 11, 21-33.

Advantages of high plane rearing are summarized as follows :—

By generous feeding for the first 8 months the calf is hurried through the stage when it can only utilize expensive types of feeding stuffs, and quickly reaches the stage when it can make good use of roughages which its fellow of possibly the same age, but reared on a low plane, can do nothing with. The proof of this, if proof is needed, is to be found in the way in which it is customary to treat beef bred calves in their first winter. These calves, born in the spring, have suckled their mothers all the summer. They are weaned in the autumn and are quite commonly wintered on a diet composed exclusively of poor quality meadow hay. Yet, surprising though it may seem, such calves do not appear to suffer any serious ill effects but continue to grow and in all the circumstances thrive amazingly well. It is the fact that these calves were reared on a high plane that enables them to thrive in this way on such poor fare, rather than the fact that they were beef bred, though it is their breeding which usually receives all the credit.

Generous rearing, even though it be followed by periods of most economical winter feeding, will shorten the time during which the animal must be kept before it can be fattened exclusively on grass by as much as 12 months.

The animal will not be excessively heavy before it can be got fat.

The costs of production will be materially reduced, a minimum of concentrates will be used and a maximum of grass and roughages.

A better carcass is finally obtained. The conformation of an animal is adversely affected by malnutrition in its early life, moreover it is permanently affected and no amount of generous feeding subsequently will undo the harm that has been done.

1012* WILKINSON, J. H. S.

Welsh Mountain Ewes as a Source of Grassland Breeding Ewes.
J. R. Agric. Soc. 1949, 110, 76-88.

Trials have been conducted on the Cambridge University Farm in an attempt to use regular draft Welsh Mountain ewes as a source of cross-bred ewes for grassland conditions. For the first three years of the trials Welsh ewes were mated with Border Leicester and Dorset Horn rams, and the conclusions drawn from this experience were as follows :—

- (i) The Welsh Mountain ewe has proved to be a satisfactory foundation for the breeding of grassland ewes ; both crosses appeared to thrive equally well either entirely on grass or partly folding.
- (ii) The Border Leicester cross showed great uniformity ; this was lacking in the Dorset Horn cross.
- (iii) The Border Leicester \times Welsh ewes were more prolific, averaging 158 per cent. lambs born alive for every one hundred ewes mated, and 154 per cent. reared ; as against 136 per cent. lambs born alive and 129 per cent. reared for the Dorset Horn \times Welsh ewes.
- (iv) Wether lambs of both crosses fattened readily.

After three years it was decided that the Border Leicester \times Welsh ewe was a more satisfactory breeding ewe than the Dorset Horn \times Welsh, and since then no further Dorset Horn \times Welsh have been produced.

When comparing the Border Leicester \times Welsh and the Dorset Horn \times Welsh as grassland ewes for fat lamb production, it was apparent that they both crossed well with a Suffolk ram, and the progeny could be sold fat off the ewes or fattened later where necessary. The Border Leicester \times Welsh besides being more prolific also produced a greater weight of live lamb per ewe up to eighteen weeks of age. The difference, although not very large, showed up consistently over the three years in all age groups, except in the three shear group in 1949. Nevertheless, the Dorset Horn \times Welsh ewes have produced some good quality, early maturing fat lambs when mated to a Suffolk ram, but they needed close shepherding to prevent excessive losses at lambing time.

The Welsh Mountain ewes which have been used in producing the two half-breds have proved to be very thrifty and were normally sold fat six or ten weeks after weaning their lambs. Two disadvantages were apparent with them. Firstly, unless the fields which they grazed were perfectly fenced, they were difficult to restrain. Secondly, under the higher level of feeding on lowland pasture, there was a risk that, unless carefully managed, they themselves became too fat and nourished their unborn lambs too well, thereby creating difficulties at lambing time. On the other hand, if this type of breeding policy were carried out on poor land, it is doubtful whether these difficulties would arise.

OTHER PAPERS

999* BROOKES, A. J. **The Management of Pigs.** *Farming.* 1950, **4**, 178-81.

1020* BROOKES, A. J. **Milk and Beef.** Pp. 20. Shorthorn Soc., London.

COCK, A. G. **The Limitations of Progeny Testing.** *Quart. J. Nat. Agric. Adv. Serv. Poult. Sect.* 1950 (18), 1-5.

HAMMOND, J. & SWAIN, J. B. **Farmers' Guide to Carcase Quality in Beef, Mutton and Pork.** *Fmrs' Wkly.* 1949, **31** (23), 40.

PLANT PHYSIOLOGY

985* BOOTH, V. H. & DARK, S. O. S.

The Influence of Environment and Maturity on Total Carotenoids in Carrots.

J. Agric. Sci. 1949, **39**, 226-36.

A study has been made of the effect of conditions of growing and of maturity on the concentration of total carotenoids (t.c.) in the root of the carrot, *Daucus carota* L.

Carotene comprised nearly 90% of the total carotenoids in all categories of carrot roots except the very small seedlings. Hence t.c. concentration may be used as an index of carotene concentration.

In order to develop their full t.c. concentration by autumn, carrot varieties with normal t.c. values must be sown before the end of May. High-carotene varieties must be sown at least a month earlier. 'Stecklings' grown from summer-sown seeds and examined in spring had only about a third of their fully mature t.c. value.

At the time when early and forced carrots are usually harvested the t.c. concentration is increasing rapidly.

The development of maximum t.c. in spring-sown carrots occurred in autumn at a date which varied from year to year. For high-carotene varieties maxima were not reached until November.

Each of nine varieties reached different maxima of t.c. concentration in different years at maturity. But the different varieties maintained nearly the same relative positions along the t.c. axis from year to year. In 1946 all the values were very low, and in 1945 all the values were high. An annual index has been calculated by means of which any values may be related to a hypothetical 'standard' year.

There is some evidence to suggest that carrots grown from newly harvested seed had lower t.c. concentrations than those grown from the same seed in subsequent years.

When the seeds of several varieties of carrot were sown in different localities differences in mean t.c. concentration were detectable in suitably designed experiments.

Neither thinning nor chitting affected the concentration of t.c.

Split carrots had very slightly higher concentrations, while forked carrots had about the same concentrations as normal carrots.

Roots damaged by maggots of the carrot fly had slightly higher concentrations of t.c. than clean roots.

Maximum weight was attained in autumn at about the same time as maximum t.c. But within a given sample of carrots the smallest and the very largest usually had low t.c. concentrations.

PLANT PATHOLOGY

988* HOWARD, H. W. & LYON, A. G.

'Crook Root' of Watercress.

N.F.U. Watercress Br. News Sheet. 1950, **12** (49), 7-8.

'Crook Root' of watercress, caused by a species of *Spongospora*, is at the present time by far the most important single factor controlling the growth of the crop. The symptoms of the disease are described. Brown cress is checked in its growth much more than green cress. Steps to minimise the disease are suggested.

PLANT BREEDING AND GENETICS

BELL, G. D. H.

Barley.

World Crops. 1949, **1**, 143-5.

A brief account of the important areas of cultivation, economic and agricultural significance, production and improvement thereof on a world basis.

BELL, G. D. H.

Hybrid Vigour in Plants.

Farming. 1949, **3**, 359-61.

A general account of the nature of hybrid vigour and its exploitation in breeding crop plants.

BELL, G. D. H.

Oats.

World Crops. 1949, **1**, 113-6.

A brief account, on a world basis, of the important areas of cultivation, economic and agricultural significance, level of production and means of improvement.

997* BELL, G. D. H.

Plant Breeding and Crop Production.

Farming. 1950, **4**, 101-4.

A discussion of the part that can be played by plant breeding, and the methods employed in increasing crop production.

1007* BELL, G. D. H.

The Plant Breeding Institute.

Farming. 1950, **4**, 204-9.

The past contributions of the Plant Breeding Institute are described, with the agricultural varieties that have been put on the market. A short account is included of the range and scope of the work at present in progress.

HOWARD, H. W.

Crops and Plant Breeding.

J. R. Agric. Soc. 1949, **110**, 124-34.

The sectional titles in this annual review article are:—plant breeding in Sweden; plant breeding in the U.S.A.; plant breeding in the U.S.S.R.; cereals; seeds; virus diseases; and chemicals.

989* HOWARD, H. W.

Potato Grafting Experiments. I. The Effect of Grafting Scions of Epicure on the Short-day Species *Solanum demissum*.

J. Genet. 1949, **49**, 235-41.

Experiments were carried out with one clone of the short-day species of potato, *Solanum demissum*. All plants were grown under long-day conditions, and the effect of grafting with scions of the variety Epicure, which sets a good yield of tubers under long-day conditions, was studied.

Plants grafted with Epicure scions produce tubers much earlier than those not grafted. They also do not have stolons which appear above the soil as leafy shoots. These results are easily explained, since it is obvious that the underground portions are influenced by the photoperiodic reactions of the tops.

Plants grafted a second year with Epicure produce a much bigger yield of tubers than those grafted for 1 year only—the reason for this is not understood.

Plants from tubers of plants grafted the previous year germinate quicker, flower earlier, and mature earlier than plants from tubers of plants not grafted the previous year. They do not, however, have a higher yield. These results can be explained as being due to the tubers in the previous year being conditioned by the tops.

No graft hybrids were found, but on one occasion the scion did succeed, in spite of careful experimentation, in sending a stolon below soil level and producing two tubers.

986* HOWARD, H. W. & LYON, A. G.

The Identification and Distribution of the British Watercress Species.

Watsonia. 1950, **1**, 228-33.

The two species, *Nasturtium officinale* R. Br. and *N. microphyllum* Boenn. ex Rchb. (*N. uniseriatum* Howard and Manton), and their hybrid are described. Their distribution in Great Britain has been determined from examination of sheets in nine herbaria.

HUDSON, P. S.

New Plants for Old.

Sci. Mon., N.Y. 1949, **69**, 404-7.

The introduction of plant material and its subsequent use by plant breeders for developing improved varieties are considered. An account follows of the FAO scheme for cataloguing genetic stocks.

HUDSON, P. S.

New Plants for Old.

U.N. Bull. 1950, **8**, 228-30.

Emphasis is laid upon the value of plant introduction in crop improvement, and the FAO scheme of the World Catalogue of Genetic Stocks is described (cf. *Plant Breed. Abstr.* 1949, **19**, Abst. 1692).

OTHER PAPERS

- DODDS, K. S. **Breeding of Disease-resistant Bananas.** *World Crops.* 1950, **2**, 56-9.
FYFE, J. L. **Genetical Ratios in Sainfoin (Demonstration).** *Heredity.* 1949, **3**, 381.
FYFE, J. L. **Wheat: Mainstay of the Temperate Regions.** *World Crops.* 1949, **1**, 59-62.
FYFE, J. L. & CHAKRAVARTY, A. K. **Cyanogenesis in White Clover (Demonstration).** *Heredity.* 1949, **3**, 381.
HOWARD, H. W. **Woodlice Genetics, Oat Cytology, Potato Grafting Experiments and the Systematics of Cruciferace (Demonstration).** *Heredity.* 1949, **3**, 383.
RICHENS, R. H. **Lysenko: the Scientific Issue.** *New Biology.* 1950, **8**, 9-35.
979* SACHS, L. **Vegetative Hybridization.** *Nature, Lond.* 1949, **164**, 1009-10.

SOILS AND MANURES

1000* CHILDS, E. C.

The Equilibrium of Rain-fed Ground-water Resting on Deeper Saline Water: the Ghyben-Herzberg Lens.
J. Soil Sci. 1950, **1**, 173-81.

When precipitated fresh water falls on land already occupied by sea-fed salt ground-water, we have a dynamic equilibrium with fresh ground-water perched upon the salt ground-water. The configuration is known as the Ghyben-Herzberg lens. In this paper potential functions are set up for the separate ground-water bodies and the boundary conditions are elucidated. By means of electric analogues certain particular and idealized cases are completely solved, all being steady states, although the procedure for non-steady states is indicated. The cases solved are for different sea-levels on the two opposite sides of an idealized dyke, and for the same sea level on the two sides but for five different rates of rainfall, in each case the configuration of all boundaries and also the flow nets being presented.

1005* CHILDS, E. C. & COLLIS-GEORGE, N.

The Permeability of Porous Materials.
Proc. Roy. Soc. 'A'. 1950, **201**, 392-405.

The permeability of a porous material to water is a function of the geometry of the boundary between the solid component and the pore space. Expressions of the Kozeny type purporting to represent this function are based upon the particle size or specific surface of the solids, and whilst, for engineering practice, they have given satisfaction for saturated sands, they may fail badly in other cases. By developing a Kozeny type of expression for the particular structure of a bundle of capillary tubes of assorted radii, we demonstrate the cause of the failure.

Such failure may be avoided by relating permeability to pore-size distribution, which is the factor of prime concern and which may be measured directly by even simpler means than are used to determine particle-size distribution. The pore-size distribution is arrived at by an interpretation of the moisture characteristic of the material, i.e. of the curve of moisture content plotted against pressure deficiency. A simple statistical theory, based upon the calculation of the probability of occurrence of sequences of pairs of pores of all the possible sizes, and of the contribution to the permeability made by each such pair, leads to an expression of the permeability as the sum of a series of terms. By stopping the summation at a selected upper limit of pore size one may calculate the permeability at any chosen moisture content and plot it as a function of that content. An example is presented, using a coarse graded sand specified by its moisture characteristic.

To check these calculations, experimental determinations of the permeabilities of unsaturated materials are presented, using two different grades of sand and a sample of slate dust, the results being compared with computed values. The agreement seems good, and is certainly better than that provided by the Kozeny formula as developed, with difficulty, for the purpose.

The limitations and possible improvements of our concept are very briefly discussed, and finally it is shown how a combined use of the moisture characteristic and the permeability (which is itself derivable from the moisture characteristic) leads to an expression for the coefficient of diffusion of water in the material as a function of moisture content. From this it should be possible, in principle, to calculate in suitable cases the course of water movement down a gradient of moisture content. Such a calculation awaits a satisfactory solution of the problem of non-linear diffusion.

1011* CHILDS, E. C. & COLLIS-GEORGE, N.

Movement of Moisture in Unsaturated Soils.
Trans. IVth Int. Congr. Soil Sci. 1950, **1**, 60-63.

A brief account of the work described above (*Proc. Roy. Soc.*), together with a tentative extension to structured soils.

1019* NICHOLSON, H. H.

The Control of Ground Water Level in Farming.
Agric. Progr. 1950, **24**, 112-5.

An outline of the problem, a comparison of Dutch and East Anglian conditions, and a brief description of a field experiment to investigate the influence of ground water level on crop production on Fen peat soils.

PASQUILL, F.

The Aerodynamic Drag of Grassland.

Proc. Roy. Soc. 'A'. 1950, **202**, 143-53.

An improvised drag-plate apparatus, on the principle of that used by Sheppard (*Proc. Roy. Soc. 'A'*. 1947, **188**, 208) on a concrete surface, but suitably modified in design, has been used for exploratory measurements of the aerodynamic drag of grassland. The grass cover was variable (1 to 15 cm. in height), and measurements were made at a number of positions (not simultaneously) in order to obtain an approximate representative value of the drag over a considerable area. Wind velocities were in the region of 500 cm./sec. and, judged in terms of the Richardson number, effectively adiabatic conditions of flow prevailed.

The drag (τ_0) and the simultaneous vertical distribution of wind velocity (u) up to a height of 2 m. were found to be expressible in terms of the law well established in the laboratory, i.e.

$$u_z = \frac{1}{k\sqrt{\rho}} \left(\frac{\tau_0}{\rho} \right) \log_e \left(\frac{z-d}{z_0} \right).$$

with k (von Kármán's constant) = 0.37, d (the zero plane displacement) = 8 cm. and z_0 (the roughness parameter) = 0.66 cm. For reasons which are discussed the drag measurements are regarded as approximate, and the close agreement of the numerical value of k with the laboratory value of 0.4 is probably fortuitous. However, the general consistency achieved in this preliminary application suggests that the technique could be profitably developed for a critical investigation of the relation between drag and wind profile and its dependence on atmospheric stability.

In a brief discussion of previous work some evidence is now provided for the validity of the Reynolds formulation of the turbulent shearing stress. Attention is drawn to the application of the present results in treatments of the diffusion of matter in the lower atmosphere.

PASQUILL, F.

Some Further Considerations of the Measurement and Indirect Evaluation of Natural Evaporation.

Quart. J. R. Met. Soc. 1950, **76**, 287-301.

A previous observational study (Pasquill, *Proc. Roy. Soc. 'A'*. 1949, **198**, 116) has been supplemented by further measurements of evaporation and the associated vertical profiles of wind velocity and vapour pressure in the first two metres above a clayland pasture with grass of moderate length, mainly in effectively adiabatic conditions of flow. The evaporation measurements, using a simple form of soil evaporimeter, included two series of statistically designed measurements, in order further to examine the "reliability" of the technique. The data so obtained, though not comprehensive, indicate no substantial error due to the necessary isolation of test soil from underlying layers, but there is a suggestion that the rates of evaporation ultimately adopted might be underestimates, owing to unavoidable disturbance of root and soil continuity in the vertical at the perimeters of the soil cores contained in the evaporimeters.

The observed rates of evaporation (E_o) are compared with those computed (E_c) from the following formula, which is based on the Prandtl form of the law relating drag and wind profile over a rough surface in adiabatic conditions,

$$E_c = \frac{\rho k^2 (u_2 - u_1) (q_1 - q_2)}{\left[\log \left(\frac{z_2 - d}{z_1 - d} \right) \right]^2}$$

where u_1 , u_2 , q_1 , q_2 , are the wind velocities and specific humidities at heights z_1 , z_2 above the soil surface, d is a 'zero point displacement' associated with the vegetation cover, ρ is air density and k is von Kármán's constant, of magnitude 0.4. For the present measurements the usual "roughness parameter," deduced from the wind profiles, was 0.51 cm. as compared with 0.25 cm. for the previous series. The two series include 19 separate determinations of rate of evaporation over periods of about one hour, and in terms of different sections of the observed profiles, provide 41 values of E_c/E_o in effectively adiabatic conditions, with wind velocities at a height of 2 m. ranging from 3 to 9 m/sec. The mean value of E_c/E_o is 0.99 and the individual deviations from 1.0 are within 10, 20 and 30 per cent. in 24, 66 and 90 per cent. of cases. It is demonstrated that deviations of this order are to be expected from local variations in the various factors involved.

Although some *a priori* uncertainty remains concerning the precise validity of the evaporation measurements, the consistency so demonstrated in terms of a semi-theoretical treatment which has been established in other connections (Calder: *Quart. J. Mech. Appl. Math.* 1949, **2**, 153) suggests that the ultimate result may be accepted with confidence. Brief consideration is then given to the validity and practicability of applying the above formula to evaporation from areas of growing crops.

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STATISTICS

WISHART, J.

Field Trials II : the Analysis of Covariance.

Tech. Comm. No. 15. Comm. Bur. Pl. Breed. Genet., Cambridge, 1950. Pp. 35. 3s. 6d.

This bulletin carries the subject of Field Trials into the domain of those topics which are commonly referred to as comprising the "Analysis of Covariance". The object is to assist the investigator still further in reducing his experimental errors by pointing out how observations made on variates other than those in which he is specifically interested may be used, by means of a special arithmetical technique, in the statistical analysis of his results. In so doing it is necessary to have an understanding of that part of statistical methods which deals with regression and correlation analysis. The object throughout the bulletin is to convey this information in non-mathematical terms, and to present the results in a computing technique which is as simple as it is possible to make it, and which can be followed by the experimenter who is unable to understand a mathematical treatment. Particular attention is directed to Tables 24 and 30, in which all the usual coefficients, including their tests of significance, can be worked out by very simple calculation. All the methods are illustrated by examples.

The bulletin goes further than has been usual with the subject; in particular it deals with the cases of one, two and three affecting variates, and indicates how the methods can be generalised to deal with any number. A novel feature is the treatment of the problem of the difference between regressions in two correlated samples.

1001* WISHART, J.

Test of Homogeneity of Regression Coefficients, and its Application in the Analysis of Covariance.

Colloques Internationaux du Centre National de la Recherche Scientifique XIII (Le Calcul des Probabilités et ses Applications) Paris, 1949, 93-99.

After displaying the known tests for a single mean, and for a difference between two means, in analysis of variance form in order to show the basic structure and general character of the tests, the analysis of variance and covariance for two variables is worked out in order that the test for the difference between two estimated regression coefficients in particular, or for the homogeneity of any number of regression coefficients in general, may be displayed in analysis of variance form to show its structure. This is the test which is at the basis of the known practical procedure (in agricultural field trials) of adjusting a dependent variate for errors in an associated variate in order to improve the precision of the trial. A description is given of the methods used in this application.

It is then noted that the above homogeneity test applies only to independent samples, whereas in many practical cases the samples will be correlated (as happens, for example, with paired samples in the test of means, or in a randomized block lay-out of agricultural plots). Attention is then directed to a new test of homogeneity of regression coefficients, due to A. H. Carter, which takes account of the existence of correlation. Analyses of variance, in parallel with those already given, are worked out, first for the special case of two correlated samples and secondly for any number of such samples, and the test then proves to be a simple variance-ratio one as in the independence case.

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